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LAUNCH MISSION SUMMARY

INTELSAT V (F3)
ATLAS/CENTAUR-55

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John F. Kennedy Space Center

INTERNATIONAL TELECOMMUNICATIONS SATELLITE INTELSAT V (F3)

The International Telecommunications Satellite Organization (INTELSAT), which has 105 member nations, provides world-wide telecommunications services through a network of geosynchronous communications satellites. In 1965 INTELSAT launched a satellite called Early Bird whose orbit was synchronized with the earth's rotation. The tiny 85-pound satellite provided 240 circuits for continuous service between Europe and North America for more than three years. Since Early Bird, INTELSAT has provided the global community with five additional generations of communications satellites, each generation larger and with greater capacity than its predecessor.

The lastest generation of spacecraft, INTELSAT V, are now being deployed by INTELSAT to meet the ever-growing demands for additional communications services. On December 6, 1980, the first INTELSAT V (designated F2) was successfully launched from Complex 36, Cape Canaveral Air Force Station (CCAFS). The satellite was positioned in geosychronous equatorial orbit at 338.5 degrees east longitude and serves as the Atlantic Ocean Region spare satellite. On May 23, 1981, INTELSAT V (F1) was successfully launched from CCAFS. F1 is positioned at 335.5 degrees east longitude and is the operational satellite.

Presently eight other INTELSAT satellites (earlier series than INTELSAT V) are in synchronous orbit providing service in the Pacific, Indian, and Atlantic Ocean regions. Five satellites provide full-time service and three serve as spares, one in each ocean region. Additionally, spare satellites and satellites of earlier series provide leased transponders, primarily for domestic services. On the ground, more than 320 antennas, located in most member-nations, provide over 840 international communications paths, more than 20,000 full-time international circuits, and ten television channels. The satellites are positioned at specific locations above the earth, providing a world-wide communications capability.

INTELSAT V has twice the capacity of present satellites and provides 12,000 two-way voice circuits, two color television channels, and accommodates analog and digital data communications. The introduction of INTELSAT V into the global communications system will benefit the world community. More than a billion people can be eyewitnesses to history as INTELSAT V expands the total communications channels among the world's continents. The INTELSAT V spacecraft was designed, developed, and manufactured by Ford Aerospace & Communications Corporation and an international team of aerospace manufacturers. This dedicated and highly experienced team includes:

Aerospatiale (France)	Mitsubishi Electric Corporation (Japan)
GEC-Marconi (United Kingdom)	Selenia (Italy)
Messerschmitt-Bolkow-Blohm (Federal Republic of Germany)	Thomson-CSF (France)

Each team member brings and contributes specific areas of expertise into the INTELSAT V program. Aerospatiale is responsible for the satellite body structure and thermal control apparatus. GEC-Marconi is building the 11 GHz beacon transmitter. Satellite attitude control systems and the sun-tracking solar array are the responsibility of Messerschmitt-Bolkow-Blohm. Mitsubishi Electric Corporation is providing the 4 and 6 GHz earth coverage antennas, power control, digital telemetry, and digital command equipment. Selenia's responsiblities include the 11 GHz antennas and RF telemetry and command equipment. The 11 GHz traveling wave tube is manufactured by Thomson-CSF. Satellite integration and the communications package development is the responsibility of the prime contractor, Ford Aerospace & Communications Corporation through its Western Development Laboratories Division in Palo Alto, California.

Spacecraft Modular Construction

The INTELSAT V spacecraft was designed in a modular configuration that allowed independent and concurrent manufacturing activities by the various team members. This modular design simplified testing, handling, and integration procedures for maximum efficency and low-risk considerations. The three main modules featured in the overall design are the antenna, communications, and support subsystems. The latter two modules form the rectangular box-shaped main body (1.65 X 2.01 X 1.77 meters [5.4 X 6.59 X 5.81 feet]) that support the solar arrays and stationkeeping thrusters.

The Antenna Module consists of a structural support for the three earth sensors; five telemetry, command, and beacon antennas; two communications antenna feed network assemblies; two large horn antennas; and four large reflectors. Three of these reflectors, hinged at the base of the antenna tower, are stowed during launch and deployed after orbit is achieved. The numerous spacecraft antennas are supported by a truss structure which is, in turn, supported at the upper end of the thrust tube of the main body. Deployment devices are provided within the truss for the 4 and 6 GHz reflectors and the west spot reflector.

The Communications Module contains all the elements of the communication subsystem, including receivers, multiplexers, traveling wave tubes, upconverters, command receivers, and telemetry transmitters. This complex communications package allows INTELSAT V outstanding telecommunications capability.

The Support Subsystem Module includes equipment for spacecraft stationkeeping. This module surrounds the apogee motor used to place the spacecraft in the desired orbit. Contained within the module are momentum wheels, thrusters, propellant tanks, batteries, and electronics for attitude control, power, telemetry and command subsystems. The solar array wings, which are stowed during launch and deployed on orbit, are mounted on the two opposite 2.01 X 1.77 meter (6.59 X 5.81 feet) sides of the main body. The solar array measures tip-to-tip 15.6 meters (51.1 feet) and the overall height of the spacecraft (to top of tower) is 6.4 meters (21.0 feet).

The Ford launch adapter provides the means of interfacing the spacecraft with the mission peculiar adapter, which is provided as part of the ATLAS/CENTAUR launch vehicle. The upper end of the launch adapter is secured to the lower end of the main body central thrust tube by a V-band clamp during launch.

Frequency Reuse

To meet the demand for greater communications capabilities, INTELSAT V utilizes two frequency reuse techniques in a single antenna--spatial separation and polarization. Spatial separation is achieved by controlling the size, shape, and pointing angle of the antenna beams. As a result, different beams of the same frequency reach different geographical areas on earth. Thus, the frequencies are "reused". On INTELSAT V, spatial separation is used for the east-west spot beams at 14/11 GHz and the hemispheric and zone beams at 6/4 GHz. With orthogonal circular polarization diversity, each 6/4 GHz band carries two sets of signals. One set is circularly polarized to the left and one to the right, thus providing twice the frequency reuse.

Ku-Band Operation

INTELSAT V marks the entry of the 14/11 GHz frequency band into the INTELSAT system. These new frequencies enable the much needed expansion of spectrum space, thereby increasing the availability of additional channel capacity.

Communications Repeater

A complex, channelized communications subsystem receives and amplifies signals from earth, routes the signals between antenna beams, and retransmits the signals to earth. The transponder equipment includes 15 receivers, 43 traveling wave tube amplifiers, and more than 140 radio frequency switches. The repeater provides 27 separate transponders which may be connected in nearly 600 different combinations of coverage areas and frequency bands. Solid state receivers, graphite epoxy filters, and contiguous channel output multiplexers are among the technical innovations introduced by Ford Aerospace & Communications Corporation on INTELSAT V.

Communications Payload

Quantity	Component	Remarks
	Communications Antennas	
2	Offset fed, shaped beam frequency reuse antennas	Freq: 6/4 GHz Size: 2.44 and 1.56 m diameter
2	Offset fed, mechanically steered spot antennas	Freq: 14/11 GHz Size: 0.96 and 1.12 m diameter
2	Earth coverage horns	Freq: 6/4 GHz
1	Beacon antenna	Freq: 11 GHz
	Receivers	All solid-state
4	14 GHz	2 active, 4 redundant
11	6 GHz	5 active, 6 redundant
	Traveling Wave Tubes	
10	11 GHz, 10 w dual collector	6 active, 4 redundant
33	4 GHz, 4.5 w and 8.5 w single collector	21 active, 12 redundant
	Upconverters	
10	4/11 GHz	6 active, 4 redundant
	Transmitters	
2	Beacon	Freq: 11.196 and 11.454 GHz

Communication Antennas

The antennas which provide coverage as previously described employ such advanced design features as dual-polarized low-axial radio feed elements and extremely lightweight feed distribution networks. These items, as well as the antenna tower and reflectors, are made of graphite epoxy for extremely low weight and high temperature stability.

Telemetry, Command, and Ranging

The telemetry, command, and ranging subsystem is used to control the spacecraft during transfer orbit and on-station operations. The major elements of the subsystem include antennas, telemetry and command units, and a transponder. Antennas are packaged in a single assembly except for the two telemetry earth coverage horns. Two command antennas receive signals from earth and three transmit antennas telemeter spacecraft data back to earth. The command subsystem provides operational ground control for many spacecraft functions through a microwave link consisting of two ring slot antennas, two command receivers, and two command units. Diagnostic data and subsystem status are transmitted to the ground via two independent and redundant channels.

Attitude Control

The attitude control subsystem provides active stabilization of the spacecraft. In transfer orbit, the spacecraft is spin-stabilized by means of active nutation control electronics firing hydrazine thrusters. Attitude determination is derived from earth sensor and sun sensor data, processed by the attitude determination and control electronics. After injection into synchronous orbit, the spacecraft is despun and the solar arrays and antenna reflectors deployed. The spacecraft roll axis is aligned to the sun line by firing hydrazine thrusters. Slowly rotating about the roll axis until the earth is viewed by the geostationary earth sensors, the spacecraft is then locked onto the earth by switching the attitude determination and control electronics to stationkeeping mode when the pitch axis is parallel to the earth spin axis. Finally, one of the redundant pair of momentum wheels is spun up. In the normal on-station mode, pitch control is maintained by momentum bias. Roll and yaw control is accomplished by firing small hydrazine thrusters. Three geostationary infrared sensors provide earth reference data.

Propulsion

The propulsion subsystem, excluding the apogee motor, is based on conventional catalytic hydrazine thrusters for transfer orbit and normal geostationary operations. North-south stationkeeping is performed by electrothermal hydrazine thrusters which are more efficient than catalytic thrusters. As a result, approximately 45 kg (100 lb) less hydrazine fuel is required for the mission. The electrothermal units are backed-up by the conventional catalytic thrusters. Attitude control, stationkeeping, and various launch maneuvers are controlled by the propulsion subsystem, consisting of two cylindrical tanks and 20 thrusters which range form 0.13 N (0.03 lb) to 22.2 N (5.0 lb) thrust.

Thermal Control

Temperature control in the spacecraft is accomplished by using conventional passive techniques including selective location of power dissipating components, selection of surface finishes, and regulation of conduction paths. The basic passive design is augmented with flight-proven heater elements for components having relatively small allowable temperature ranges. The thermal control design concept employs an insulated communications module, support subsystem module, and feed support structure which use multilayer insulation, single

layer thermal shields, and low emittance surfaces. Fused silica optical solar reflector radiators are used to radiate the heat dissipated from the modules.

The advanced design and maximum use of flight-proven hardware in INTELSAT V will provide INTELSAT with high-capacity, reliable communicatins for years to come. There are nine spacecraft currently scheduled for the INTELSAT V generation, and consideration is being given to additional procurment. Intended to begin service in 1981 over the Atlantic and Indian Oceans, INTELSAT V will ensure economical and expanded communications capabilities for the global community throughout the decade.

ATLAS/CENTAUR VEHICLES

The two-stage ATLAS/CENTAUR combination, built by General Dynamics/Convair (GDC), has launched a wide variety of scientific and technological spacecraft. These have included Surveyors to the moon, Mariners to Venus, Mercury, and Mars, Pioneers to Jupiter and Saturn, and INTELSAT, COMSTAR, and FLTSATCOM (DOD) communications satellites into geosynchronous earth orbit. For the launch of INTELSAT V, various sequence and configuration changes have been incorporated into the ATLAS/CENTAUR launch vehicle (from previous INTELSAT IVA launches) to improve performance for accommodating the heavier spacecraft weight and to assist spacecraft spinup.

The 21.3 meter (70 foot) first stage is an uprated version of the flight-proven ATLAS vehicle. The Rockwell International/Rocketdyne MA-5 engine system burns RP-1, a highly refined kerosene, and liquid oxygen. The MA-5 utilizes two main engines, a 1,646,000 Newtons (370,000 pounds) of thrust booster with two thrust chambers, and a smaller sustainer with a single chamber that produces 266,900 Newtons (60,000 pounds) of thrust. Two smaller vernier engines which help control the vehicle in flight are also burning at liftoff, for a total thrust of 1,917,000 Newtons (431,000 pounds). Vehicle weight varies according to payload. For this mission, total vehicle weight at liftoff is about 148,200 kilograms (326,725 pounds).

After 139 seconds of flight the booster engine cuts off (BECO) and is jettisoned along with supporting structures. An ATLAS thus drops a large portion of its structural weight without having to ignite an engine in flight, as a separate stage must. The insulation panels are then jettisoned at BECO + 25 seconds. Nose fairing jettison time occurs at BECO + 70 seconds (approximately 3 1/2 minutes into the flight). The sustainer and vernier engines continue to burn until propellant depletion, at a little over four minutes.

The only radio frequency system on the ATLAS is a range safety command system, consisting of two receivers, a power control unit, and a destruct unit. The ATLAS can be destroyed in flight if necessary, but otherwise receives all its control directions from the CENTAUR stage.

The CENTAUR stage sits above the ATLAS, on a barrel-shaped interstage adapter. The ATLAS and CENTAUR separate two seconds after the ATLAS burns out. Eight small retrorockets near the bottom of the ATLAS fuel tank then back this stage away from the CENTAUR.

The CENTAUR stage is 14 meters (46 feet) in length. Exclusive of payload, it weighs about 15,650 kilograms (34,500 pounds) when loaded with propellants. The main propulsion system consists of two Pratt & Whitney engines burning liquid oxygen and liquid hydrogen, producing 146,800 Newtons (33,000 pounds) of thrust in the vacuum of space in which they are designed to operate. These engines can be stopped and restarted, allowing the CENTAUR to coast to the best point from which to achieve its final trajectory before igniting for the final burn. While coasting, the stage is controlled by 12 small thrust engines, powered by hydrogen peroxide (H_2O_2). The amount of H_2O_2 tanked aboard the CENTAUR for this flight is 320 kilograms (145 pounds). These thrust engines hold the stage steady and provide a small constant thrust to keep the propellants settled in the bottoms of their tanks, a necessity for a second or third burn.

A cylindrical nose fairing with a conical top sits on the CENTAUR and protects the spacecraft. The standard ATLAS/CENTAUR nose fairing is used for the INTELSAT mission resulting in a total vehicle height of 39.9 meters (131 feet). Both ATLAS and CENTAUR stages are three meters (10 feet) in diameter.

The CENTAUR astrionics system provides integrated flight control for both itself and the ATLAS. The heart of this system is an airborne Digital Computer Unit (DCU), built by Teledyne. The DCU is an advanced, high-speed computer with a 16,384 word random access memory. It issues commands which control the sequence of operations for both stages. It also issues steering commands to the engines, operating on guidance information furnished by the Inertial Measurement Group (IMG). The IMG, built by Honeywell, determines how accurately the vehicle stages are following the planned flight path, allowing the DCU to correct for any deviations by issuing new steering commands.

The DCU and other electronic packages are mounted in a circle around a conical equipment module, located above the upper CENTAUR tank. In addition to providing guidance and determining the sequence of events, these packages perform the navigation, autopilot, attitude control, and telemetry and data management functions for both stages. The CENTAUR also has a ground-controlled destruct system similar to that on the ATLAS, in case the stage must be destroyed in flight.

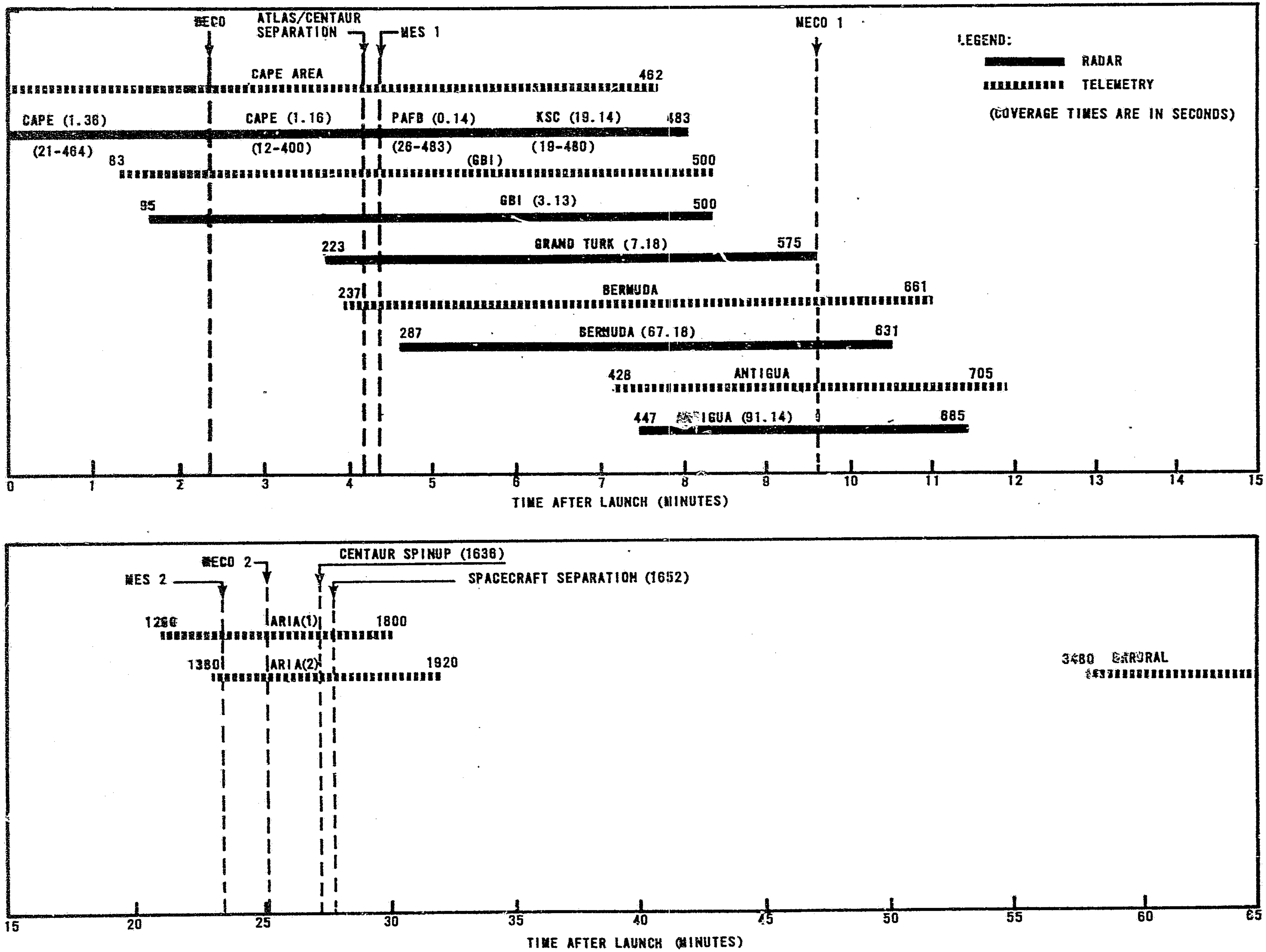
The CENTAUR utilizes the most powerful propellant combination available, has a light-weight structure, and the longest burn time of any stage now in service. This gives it more total energy for its size than any stage yet built.

FLIGHT PLAN

The ATLAS/CENTAUR vehicle will rise vertically from Launch Complex 36-B until 15 seconds of flight time have elapsed. For INTELSAT V missions, ATLAS BECO criterion has been reduced from a vehicle acceleration level of 5.7g to 5.5g (to reduce the possibility of POGO phenomenon occurring). During the interval from 2 to 15 seconds, the CENTAUR DCU will roll the vehicle from the launch pad azimuth (115 degrees) to the desired flight azimuth of 97.6 degrees. Removal of Ascension Island tracking constraint permits use of a more northerly flight azimuth (from 101 degrees to 97.6 degrees) and a less eccentric parking orbit. Operationally, this change will result in a switch to ARIA aircraft for primary coverage of CENTAUR second burn and spacecraft separation events.

The ATLAS booster and the first burn of the CENTAUR will inject the vehicle into a 148 kilometer (80-nautical-mile) perigee by 358 kilometer (193-nautical-mile) apogee elliptical parking orbit. During the first portion of the parking orbit a zero-g coast will be incorporated instead of continual settling thrust. After an approximate 14-minute coast period in the parking orbit, a second CENTAUR burn near the first equatorial crossing will provide a small plane change and inject the vehicle into an inclined Hohmann transfer ellipse. After second Main Engine Cutoff (MECO 2), the CENTAUR will execute a turn to orient the INTELSAT V spacecraft to the required attitude for the transfer orbit. This attitude places the spacecraft spin axis normal to the plane of the transfer orbit, with the antenna end of the spacecraft pointing in a generally southern direction. Prior to spacecraft release, a 2-rpm spinup of the CENTAUR/INTELSAT V will be executed to impart the initial increment of spin rate required for spacecraft stabilization during transfer orbit coast to apogee. The spacecraft weight at separation is 1,924 kilograms (4,242 pounds). The INTELSAT V spacecraft performs additional spinup shortly after separation to stabilize the spacecraft during the 5.2 hour coast to apogee. The CENTAUR will turn approximately 90 degrees after spacecraft separation, and perform a retromaneuver. The retromaneuver includes a propellant tank blowdown through the main engines to increase the separation distance from the spacecraft.

The INTELSAT V missions require injection of the satellites into geosynchronous equatorial orbit. The nominal parameters of such an orbit are a 23.935-hour period, an altitude of 35,788 kilometers (19,324 nautical miles), near zero eccentricity, and a zero inclination with respect to the equatorial plane. An apogee motor on the INTELSAT V is used to circularize the transfer orbit and reduce the inclination to near zero. Final positioning in geosynchronous orbit is provided by the spacecraft, which drifts to its assigned place in the INTELSAT global network and then fires its hydrazine-powered positioning and orientation system to stop the drift motion. The initial operating position for INTELSAT V (F3) will be over the Indian Ocean.



ANTICIPATED RADAR AND TELEMETRY COVERAGE, INTELSAT V(F3)

INTELSAT V (F3) SELECTED TRAJECTORY INFORMATION

Events	Time (seconds)	Time (min:sec)	Surface Range (nautical miles)	Altitude (nautical miles)
Liftoff	T=0	---	0	0
BECO	T+139	2:19	42	30
SECO	T+254	4:14	217	77
ATLAS/CENTAUR Separation	T+256	4:16	221	77
MES 1	T+263	4:23	234	79
MECO 1	T+575	9:35	1087	89
MES 2	T+1422	23:42	4424	86
MECO 2	T+1516	25:16	4839	95
Spacecraft Separation	T+1651	27:31	5524	155
Transfer Orbit at First Apogee	T+20,378	339:38	9112	19,324

NOTE: All data are nominal and may vary, depending on exact launch date, launch time, and spacecraft flight weight.

LAUNCH WINDOWS

The planned launch date for INTELSAT V (F3) is December 9, 1981. The launch windows for this date, plus 14 additional days, are as follows:

Date	First Window		Second Window		Third Window		Window Duration (minutes)
	EDT Open - Close	GMT* Open - Close	EDT Open - Close	GMT* Open - Close	EDT Open - Close	GMT* Open - Close	
Dec. 9	1829 - 1838	2329 - 2338	1918 - 1936	0018 - 0036	2017 - 2033	0117 - 0133	9-18-16
10	1830 - 1839	2330 - 2339	1919 - 1936	0019 - 0036	2017 - 2034	0117 - 0134	9-17-17
11	1831 - 1840	2331 - 2340	1919 - 1937	0019 - 0037	2018 - 2035	0118 - 0135	9-18-17
12	1832 - 1840	2332 - 2340	1920 - 1938	0020 - 0038	2019 - 2036	0119 - 0136	8-18-17
13	1833 - 1841	2333 - 2341	1921 - 1939	0021 - 0039	2020 - 2036	0120 - 0136	8-18-16
14	1834 - 1842	2334 - 2342	1921 - 1939	0021 - 0039	2020 - 2037	0120 - 0137	8-18-17
15	1835 - 1842	2335 - 2342	1922 - 1940	0022 - 0040	2021 - 2038	0121 - 0138	7-18-17
16	1836 - 1843	2336 - 2343	1923 - 1941	0023 - 0041	2022 - 2039	0122 - 0139	7-18-17
17	1837 - 1844	2337 - 2344	1923 - 1941	0023 - 0041	2022 - 2039	0122 - 0139	7-18-17
18	1838 - 1844	2338 - 2344	1924 - 1942	0024 - 0042	2023 - 2040	0123 - 0140	6-18-17
19	1839 - 1845	2339 - 2345	1925 - 1943	0025 - 0043	2023 - 2041	0123 - 0141	6-18-18
20	1839 - 1846	2339 - 2346	1925 - 1943	0025 - 0043	2024 - 2041	0124 - 0141	7-18-17
21	1840 - 1846	2340 - 2346	1926 - 1944	0026 - 0044	2025 - 2042	0125 - 0142	6-18-17
22	1840 - 1847	2340 - 2347	1926 - 1944	0026 - 0044	2025 - 2042	0125 - 0142	7-18-17
23	1840 - 1847	2340 - 2347	1927 - 1945	0027 - 0045	2026 - 2043	0126 - 0143	7-18-17

*Note: All GMT launch times that occur after midnight are actually one day later in GMT time than the date shown opposite that entry in the left column.